VOICE ACTUATED LIGHT SWITCH

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SUPERVISOR'S CERTIFICATION

After having read the thesis paper prepared by ROZIAH BINTI MAHAMUD titled VOICE ACTUATED LIGHT SWITCH, the supervisory camp are satisfied with the thesis paper as a partial fulfilment for the award of undergraduate degree with honours in Electronics and Telecommunication Engineering.

9/10/97

Submission Date

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VOICE ACTUATED LIGHT SWITCH

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Dedicated to:

Mahamud and Sukatri

and to

my brothers and sisters

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TABLES OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Thesis "Voice Actuated Light Switch" is a project where whistle sound (high frequency voice) is used to actuate the light. Light Emitting Diode (LED) is used in this project as an indicator. The LED will light up when the circuit is closed and vice versa when the circuit is open. The whistle sound will captured by a microphone and then this sound is converted to electrical signal for actuating the LED. The same sound is used to de-activate the light. In other words, whistle sound is replacing the switch to on and off the LED. Besides the schematic diagram, detail explanation on the theoretical part of each electrical components used are also included in this thesis. Signal processing in major components are also discussed to know how sound is converted to electrical signal and to know how this signal affect the overall circuit. This thesis also describe the advantages and disadvantages and also problems encountered during the developing of this project.

ABSTRAK

Tesis "*Voice Actuated Light Switch*" ini adalah satu projek yang mana bunyi wisel (bunyi berfrekuensi tinggi) digunakan untuk menggerakkan litar. Diod Pancaran Cahaya (LED) digunakan di dalam projek ini sebagai penunjuk. Diod Pancaran Cahaya ini akan menyala apabila litar dilengkapkan dan akan padam apabila litar diputuskan. Bunyi wisel tersebut akan diperangkap oleh mikrofon dan kemudian bunyi ini akan ditukarkan kepada isyarat elektrik yang seterusnya akan menggerakkan litar. Bunyi yang sama diaplikasikan untuk memutuskan litar tadi. Dengan perkataan lain, bunyi wisel berperanan menggantikan peranan suis untuk menghidupkan dan mematikan Diod Pancaran Cahaya. Selain daripada gambarajah skematik, penerangan terperinci tentang teori komponen elektrik yang digunakan juga turut dimasukkan dalam tesis ini. Pemprosesan isyarat di dalam komponen utama diperbincangkan untuk mengetahui bagaimana bunyi ditukar kepada isyarat elektrik dan bagaimana isyarat ini mempengaruhi litar. Tesis ini juga mengandungi kelebihan dan kekurangan serta masalah-masalah yang dihadapi sepanjang perkembangan tesis.

CHAPTER 1

INTRODUCTION

Switch is one of the most important component used to control the electrical appliances such as light, radio, television and others. But, nowadays, it is not that practical. Everybody like to use a more simple device which is easy to operate.

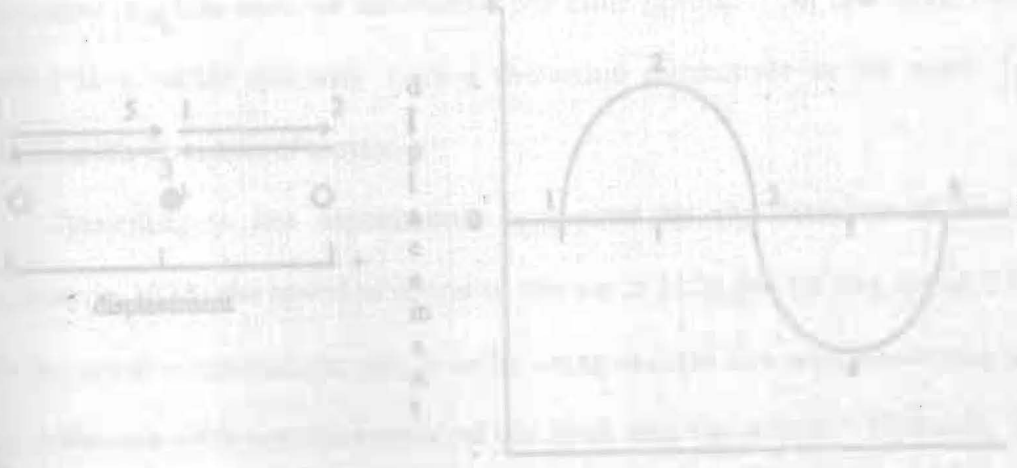
As the new technology comes and based on the people's demand, portable switch was designed. It is called the remote control. People can use it to control some of the electrical appliances from a distant. Moreover, remote control was made as a compact device where a single remote control is use to control a few electrical appliances.

Since the remote control unit is portable and small, uncertainty comes when they lose the remote control or misplace it somewhere. So, people found that remote control is not the best way to control their electrical appliances. Researches are done to replace the remote control to something that is more practical.

This thesis is a project done to replace the utilisation of the remote control. Instead of using switch or remote control, this project used whistle sound to control the electrical appliances for example light. Whistle sound is so convenient to be use as a control device because it is portable and even you can whistle yourself without using any devices.

Besides controlling light, this project is also applicable to other electrical appliances with some changes in the components used especially the relay. The bigger the electrical appliance being to control, the bigger the relay must be used.

If we decide not to use whistle sound to actuate this circuit, we can change the resistor in the audio amplifier and the circuit can be control by another device. Basically, increasing the resistance in the audio amplifier will give us chances to use higher frequency sound as a control device. It is basically because the audio amplifier will be less sensitive.



CHAPTER 2

VOICE

2.1 Nature of Sound.

Voice which is used to actuate this circuit a kind of sound. Sound itself has a dual nature, either it is considered a physical disturbance in a medium such as air, or a psychophysical perception resulting from nerve impulses stimulating the acoustic cortex of the brain [1].

A medium that has elasticity and inertia is required for this wave motion to be transmitted from the source to the receiver. In this project, air (known as having these two characteristics) is the medium of sound propagation. It is propagated through the air by virtue of elastic and inertial forces acting on the air particles.

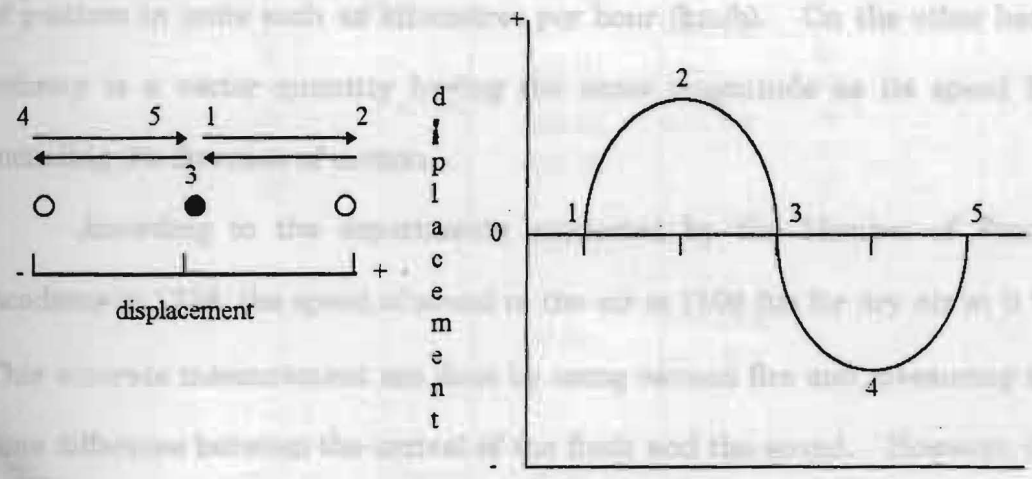


Fig. 1 Longitudinal particle motion as in sound waves in air

Sound waves are propagated by longitudinal vibrations of air particles for instant by vibrations parallel to the direction of sound travel as in Fig. 1 above. It is also known as a harmonic motion.

In order the sound to be capture by the microphone (receiver), the sound must be in the form of pressure ripple. Microphone is not respond to the static atmospheric pressure because sound cannot propagate in the vacuum. The weakest sound the human ear can hear is about 20 micropascals (20 μpa) which will create a pressure ripple only one five-thousandth of a millionth of the atmospheric pressure.

The wave of sound pressure are called periodic waves because they repeat over and over. Bear in mind that periodic waves need not be sine waves, but it is only repetitive waves.

2.2 Speed of Sound

The speed of sound can be measure. But people are always confused between the terms speed and velocity because these two words are often equated. Technically, these terms are not alike. Speed means rate of change of position in units such as kilometres per hour (km/h). On the other hand, velocity is a vector quantity having the same magnitude as its speed but including it's direction of motion.

According to the experiments conducted by the Member of French Academy in 1738, the speed of sound in the air is 1106 ft/s for dry air at 0 °C. This accurate measurement are done by using cannon fire and measuring the time difference between the arrival of the flash and the sound. However, the speed of sound in air is commonly rounded off to 1130 ft/s (344 m/s) in dry air at a temperature of 20 °C [1]. For practical purposes and under normal

conditions the speed of sound in air and various other media is given in Table 1 below.

Media	Meters/Second	Feet/Second
Air, 21 °C	344	1130
Water, fresh	1480	4860
Water, salt, 21 °C, 3.5% salinity	1520	4990
Plexiglass	1800	5910
Wood, soft	3350	11,000
Fir timber	3800	12,500
Concrete	3400	11,200
Mild steel	5050	16,600
Aluminium	5150	16,900
Glass	5200	17,100
Gypsum board	6800	22,310

Table 1 Speed of sound and various media

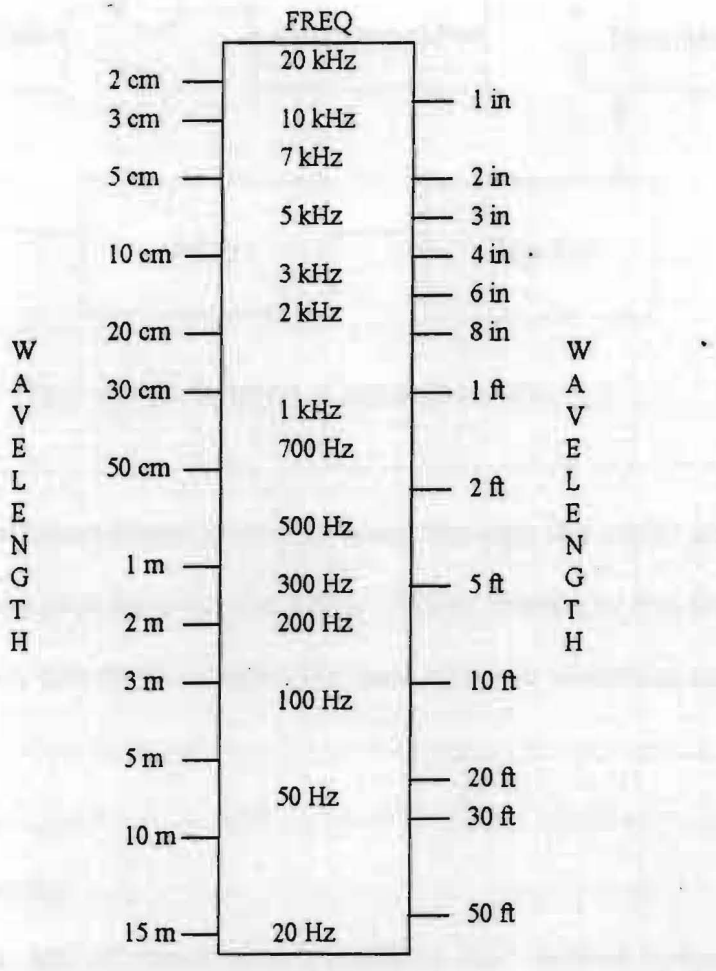
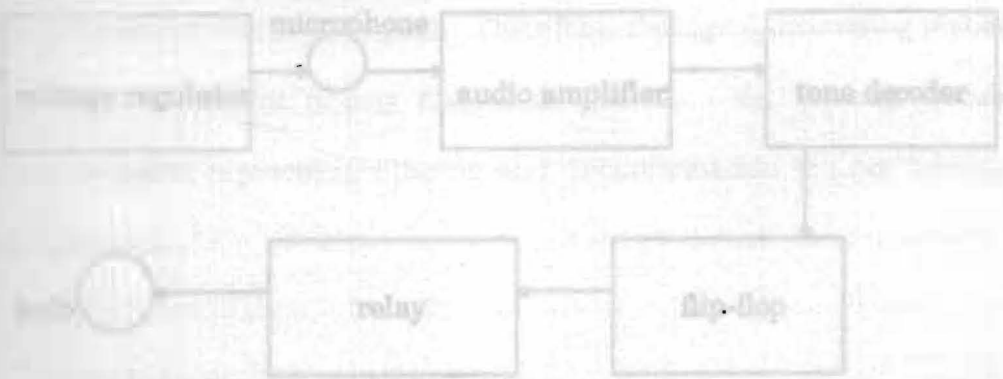


Fig. 2 The relationship of the wavelength of sound in air to frequency

2.3 Whistle Sound As an Actuator

This circuit is actuated by a whistle sound. Whistle has quite a high frequency. A man's speaking voice produces sound with frequencies around 145 Hz while a woman's voice is 230 Hz in averages [9]. So, we can make an approximation that the ranges of the whistle sound is between 145 Hz to 1000 Hz. With a special scale, distance between successive peaks (wavelength) and the sound frequency can be measure. Fig. 2 above showing a graphic solution of the relationship of the wavelength of the sound in air to frequency (speed of sound taken as 1130 ft/s). Hence, the furthest distance between the sound source and the receiver can be estimated.



CHAPTER 3

SIGNAL PROCESSING

3.0 Block Diagram

The signal flows through the circuit is illustrated by a block diagram in the Fig. 3 below:

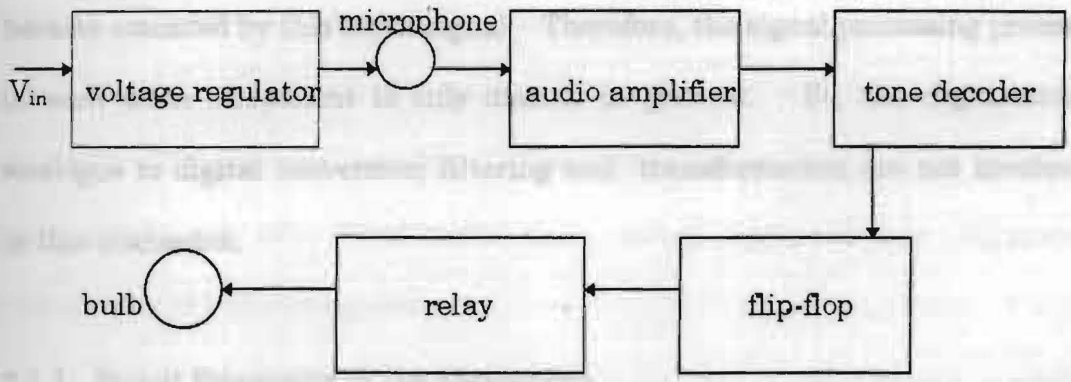


Fig 3 Block diagram of the signal flow

Basically, the input signal (voice) passing through the audio amplifier, tone decoder, flip-flop and light up the LED. Then, it goes to the transistor and relay. After all, the signal goes to the load which is electrical appliance (bulb).

3.1 Signal Processing

Signals is a set of waveforms contains the desired information. Signals can be interfered by noise which come from the surroundings. The

most popular form of signal is signal which come from a sensor. Other than that, signal can come from imaging sensor which provide pictures of generally three-dimensional object scenes. Signal also can be a collection of waveforms taken by an array of sensor spatially arranged [4]. However, this thesis only use whistle sound as an input signal.

It is quiet hard to differentiate between the whistle sound and the other loud noise comes from other sources. Considering to operate in the silence room, the circuit treats the whistle sound as the only input signal.

We are only interested in what happened to the whistle sound after it was captured by the microphone and also what happened next until the circuit became actuated by this input signal. Therefore, the signal processing process in each main component is only discuss in general. So, the digitisation, analogue to digital conversion, filtering and transformation are not involved in this discussion.

3.1.1 Signal Processing in the Microphone

This project use whistle sound to actuate the circuit. The sound is captured by the electret microphone located in one part of the circuit. The microphone converts sound energy into electrical analogue. It is mean that the microphone serve to transform acoustic energy into the electrical form required by the audio system.

In principle, the microphone should do this without changing the information content inside the sound in any way. But, whistle sound did not contains any important information. So, we do not fear of loosing anything while the sound converted to electrical signal.

A microphone should therefore do three things:

1. For normal sound levels it must produce an electrical signal that is well above its own electrical noise level.
2. For normal sound levels the signal it produces must be substantially undistorted.
3. Together with its associated equipment, it should ideally, for a particular sound source, respond almost equally to all significant audio frequencies present.

With today's high-quality microphones the first two objectives are easily met. In order to achieve a signal that can be transmitted safely along the microphone lead, a transformer or amplifier is often required so close to the head as to be regarded as part of the microphone itself.

Microphone differ from one another in the way that air movement is converted into electrical energy. The most important types in current professional use are electrostatic (also called condenser or capacitor microphones and including electrets).

Whistle sound travel from the source to the electret microphone in wave form. This wave create the air pressure which then vibrate the microphone plates. Bear in mind that electret microphone has a sealed permanent charge in the capacitor and the plates are very light. Therefore, it is very sensitive to the air pressure. The capacitive plates acted as a pickup elements.

Operation of this microphone depends on the balance of charge between plates. Unbalance charges create the input signal to the integrated circuit amplifier inside the microphone. But, the output signal from the capacitive element is extremely small. Even a short length of cable has too high a capacitance for the device to overcome. Therefore, preamplifiers are placed only millimetres away from the pick-up elements inside the microphone.

These preamplifier and also the plates are powered by the power supply. However, low voltage are required to power-up those devices since the electret elements it has a self-polarising characteristic which has no external polarising voltage.

The signal captured by this microphone must be boosted to a level suitable for processing. A microphone preamplifier usually raises the signal level from about -60 dB to something near operating level (0 to +4 dBm). To obtain the required signal level, the signal must be amplify a few more times.

Because the sensitivity of a microphone preamplifier input must be so great, electret microphone with especially high output can sometimes produce overload or the preamplifier input and clipping (excessive amplitude) at the preamplifier output. Therefore, preamplifier often contain pad networks in the input circuit, a gain loop as part of the preamplifier's feedback loop or both.

A pad is resistive network that introduces a certain amount of voltage drop, thereby reducing signal level at the preamplifier input, whereas a gain control reduces or increases the amount of signal amplification from input to output of the preamplifier.

3.1.2 Signal Processing in the Audio Amplifier

Audio amplifier use in this project contains two stages of amplifier. Originally, most audio amplifier were made of individual vacuum tubes connected in stages. Each stage accomplished some aspect of signal handling, usually increase in signal level. Amplification by definition is the use of a small voltage and/or current to control a larger voltage and/or current. A change in the small voltage and/or current (input) is reflected as a proportional change in the main voltage and/or current (output).